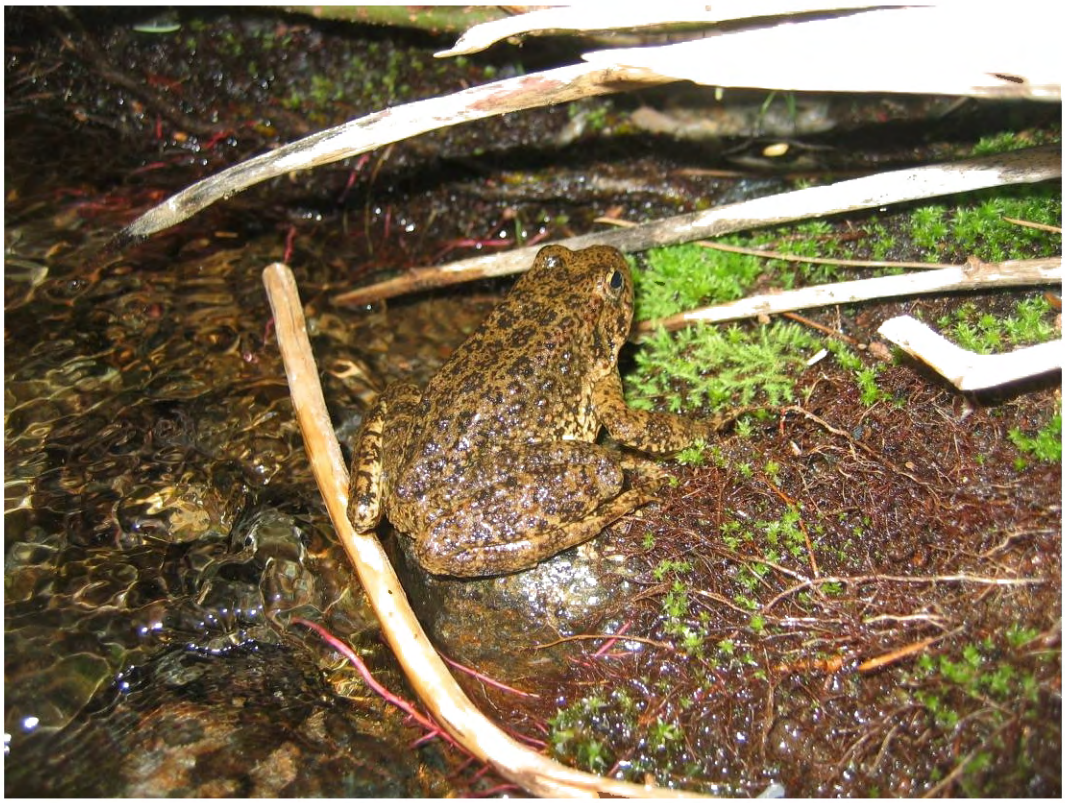
Habitat Use, Home Range, and Movements of Mountain Yellow-legged Frogs (*Rana muscosa*) in Bean and Spanish Creeks on the Plumas National Forest



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ABSTRACT

The mountain yellow-legged frog (*Rana mucosa*) is endemic to the Sierra Nevada mountains of California and Nevada and the Transverse Ranges of California where two distinct population segments, northern Sierra Nevada and southern Sierra Nevada, inhabit aquatic habitats at elevations ranging from approximately 4600ft to 12,000ft. To date no published information on the home range size or movement patterns of mountain yellow-legged frogs within stream courses in the northern Sierra Nevada Mountains exists. This study focuses on the seasonal movement patterns and home ranges, habitat associations, and distribution of mountain yellow-legged frogs within a northern Sierra Nevada stream course.

Fifty frogs, forty-seven female and three male, were affixed with radio transmitters and tracked from July 2005 through September 2007. Frog snout-vent length ranged from 57.5mm to 72.5mm at capture. Weights of radio-tagged frogs at capture ranged from 24.0g to 57.5g at capture. Mean home range of frogs was 167,032m^2 (±49,033 m^2 SE) at 95% probability and 38,030m^2 (± 12,404m^2) at 50% probability.

Frogs were associated with rocks during a majority of the relocations (73.7%). Movements away from the creek were infrequent and small in distance, and more common in the winter tracking period when off-creek pools and refugia were more abundant. Very few egg masses were encountered throughout the study period.

INTRODUCTION

The mountain yellow-legged frog (*Rana muscosa*) is endemic to the Sierra Nevada Mountains of California and Nevada and the Transverse ranges of southern California where it inhabits aquatic habitats at elevations ranging from 4600ft to 12,000ft (USFWS 2002). Currently, there are four clades forming two distinct population segments (DPS) of mountain yellow-legged frogs, the northern Sierra Nevada DPS and southern Sierra Nevada DPS, with the southern DPS listed as endangered in July 2002 (USFWS 2002). All populations in the northern Sierra Nevada are listed as a candidate species under the U.S. Endangered Species Act (USFWS 2002). In the most recent literature, mountain yellow-legged frogs have been divided into two separate species, *Rana muscosa* in the southern Sierra Nevada Mountains and Transverse Ranges and *Rana sierrae* in the central and northern Sierra Nevada Mountains (Vredenberg et al. 2007). For the purposes of this report, we consider the older taxonomy through which this study's population is still considered *Rana muscosa*.

Documentation on the ecology of mountain yellow-legged frogs within the northern Sierra Nevada DPS is scarce since recent studies have focused on the ecology and extirpation factors within the southern DPS. Telemetry studies on mountain yellow-legged frogs have described the ecology, movements, and seasonal distribution in the southern DPS of mountain yellow-legged frogs (Pope and Matthews 2001). However, these populations inhabited lakes at much higher elevations than this study population which inhabits a lower elevation stream. To date, there is no published information on the home range size or movement patterns of mountain yellow-legged frogs within stream courses in the northern Sierra Nevada Mountains.

This report describes the results of a three-year of a study on the movement patterns, home range, habitat associations, and distribution of mountain yellow-legged frogs within a

northern Sierra Nevada stream course, Bean and Spanish Creeks, on the Plumas National Forest, northern California. Additionally, in this study, we attempted to determine movements of mountain yellow-legged frogs (hereafter referred to as "frogs") away from the stream course in order to determine appropriate timber harvest operating periods, riparian buffers for fuel treatments, riparian restoration, and silvicultural treatments with consideration of the ecology of this species. This three-year study was a conducted under a partnership with Plumas National Forest and personnel from the Plumas National Forest Supervisor's Office in Quincy, CA.

METHODS

Literature Review. Examination of the document, "Draft report on the movement patterns and habitat use of Ranid frogs on the Plumas National Forest," (K.R. Matthews, L.K. Vance, I. Lacan 2004) provided valuable information to be considered for pre-survey reconnaissance, survey planning, telemetry techniques, and data analysis. Number, distribution, and sizes of frogs captured at the previous study site, Bean Creek, helped to provide an idea as to expected distribution of frogs throughout the stream, and where to most effectively focus survey efforts. All survey techniques were completed according to Fellers and Freel (1995).

Study Area. This study was conducted on Bean and Spanish Creeks in the Feather River hydrologic unit of the Plumas National Forest (Figure 1). Elevations within the study area ranged from 3900ft to 4800ft. Forested habitat along the creek and within the hillsides

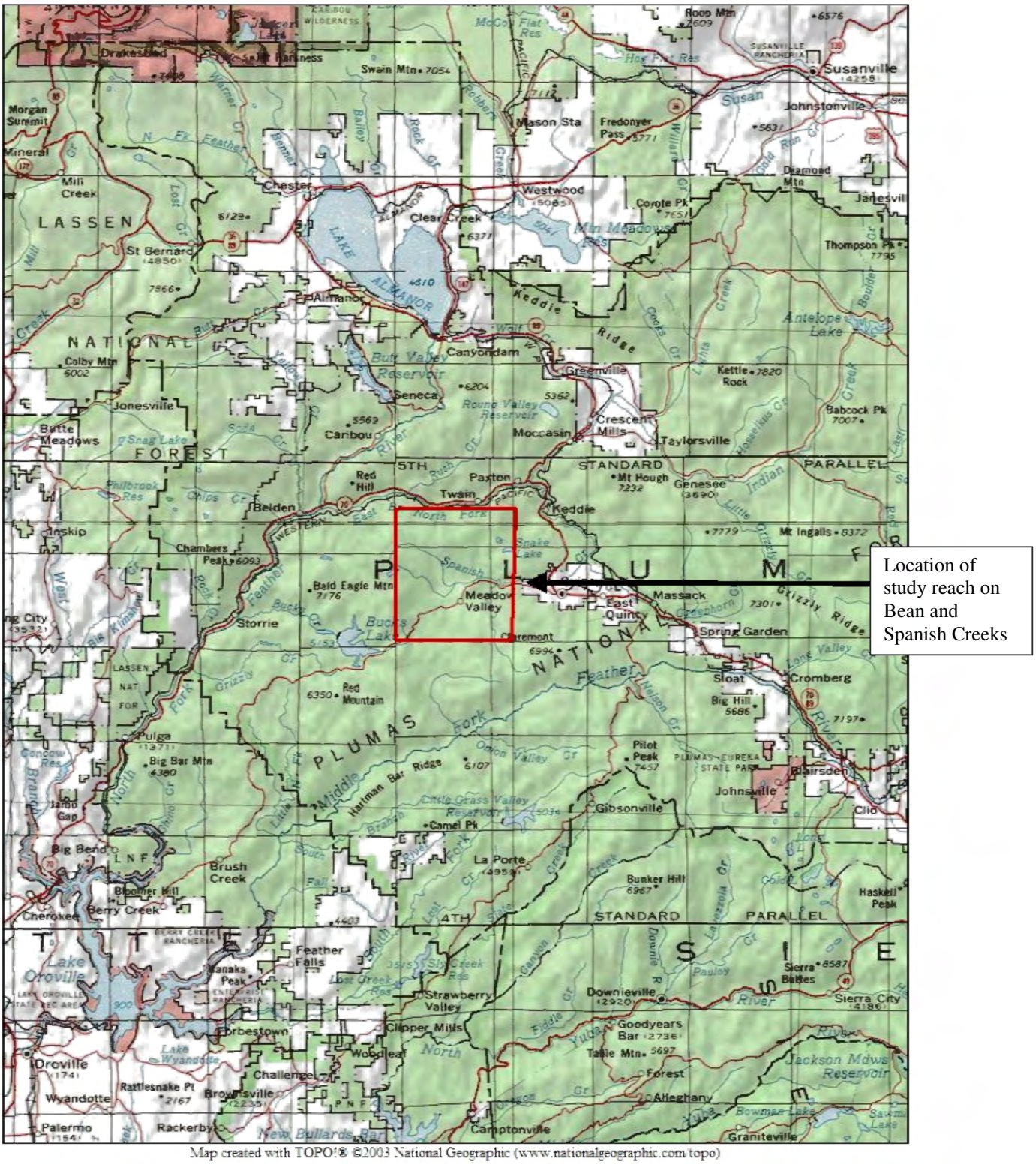
Location of study reach on Bean and Spanish Creeks
Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

Figure 1. Location of study reach on Bean and Spanish Creeks, on the Plumas National Forest, for mountain yellow-legged frog telemetry study, July 2005 – September 2007.

consisted of serpentine-modified CWHR type Sierra Mixed Conifer, size class 3 – 4, with low canopy cover of approximately 10 – 30% (Laudenslayer and Mayer 1990). Ponderosa pine (*Pinus ponderosa)* and incense cedar (*Calocedrus decurrens*) predominate this area, with only a few scattered Douglas-fir (*Pseudotsuga menzeseii*, typically a dominant tree in SMC forest type), growing near the water. This is likely a direct effect of the serpentinitic soil and rock types underlying this part of Bean Creek. Effects of past logging, burning, and hydraulic mining are apparent along some of the areas mid-reach on Bean Creek as evidenced by large expanses cleared vegetation, top soil, and substrate (personal observation). Current mining activity occurs at the downstream end of the reach in Spanish Creek.

The study reach was approximately 3.5km, with about 2.4km of the reach along Bean Creek until its confluence with Spanish Creek, and about 1.1km down Spanish Creek below the confluence with Bean Creek. Flow in the summer (about June – September) was intermittent on Bean Creek, with long stretches (up to 0.6km) being subterranean all summer. Spanish Creek had flow throughout the seasons. The substrate of both creeks is primarily boulder and bedrock, with dense vegetation of willows (*Salix* sp.) and annual reeds dominating some areas. Large woody debris is frequent throughout the study reach (see Appendix A for typical habitat photos).

Field Reconnaissance. Surveys for mountain yellow-legged frogs on two potential creeks in consideration for this study (Bean and South Fork Rock Creek, Plumas National Forest) were conducted June 22, 2005 and June 29 – 30, 2005. Through surveys at Bean Creek, nine mountain yellow-legged frogs were encountered. Surveys at South Fork Rock Creek, another tributary of Spanish Creek, yielded the detection of only one mountain yellow-legged frog, although several metamorphs and tadpoles were observed. Because of the low abundance

of mountain yellow-legged frogs at South Fork Rock Creek, this study site was abandoned for the purposes of this study.

After the first year of the study, both Spanish and Bean Creeks were surveyed through field reconnaissance. Spanish Creek was surveyed approximately 0.5km above and below the confluence with Bean Creek. Detection of seven adult frogs in Spanish Creek allowed inclusion of this reach for the final season of this project.

Frog Capture and Radio Transmitter Attachment. A California Department of Fish and Game collecting permit was obtained through our subcontractor, EartHerp, Manila, CA, before any animals were handled. Sixty-two mountain-yellow legged frogs were opportunistically captured by hand or with dipnets throughout the study period. Each frog was photographed, weighed, measured for snout-vent length (SVL), swabbed for chytridiomycosis, had its gender determined by observing the nuptial pad at the base of the inner-most finger (Stebbins 2003), and assessed for evidence of injury. If frogs appeared healthy and met the minimum size for radio attachment (55mm SVL), they were affixed with a WST2-72GL, 1.6g, 17mm x 10mm x 7mm radio transmitter (Wildlife Track, Caldwell, ID). For the initial capture on July 23 – 24, 2005, transmitters were attached to the clasp of an aluminum beaded-chain belt with 5-minute epoxy after appropriate lengths of belts were determined for each frog (Figure 2). For radio-attachments after the first capture and throughout the rest of the study period, an aluminum beaded-chain belt was looped through a hole in the epoxy covering the transmitters (Figure 2). After radio transmitter attachment, the frog was released in its capture location and observed for approximately 1 minute to determine any difficulty swimming or hopping. If the frog's movements appeared to be negatively affected by the radio transmitter, the attachment was adjusted until the frog moved freely on land and in water.

Frog Radio Telemetry. All frogs were tracked through radio telemetry initially twice a week through September 3, 2005 and once a week from September 8, 2005 to October 6, 2005, between 0600 and 2400 hours. Frogs were tracked once a month from October 2005 through April 2006 then twice a week starting May 2006 through July 2006. Frogs were captured again September 2006 and tracked once a week through November 2006, and again captured in April 2007 and tracked once a week through August 2007, and one last time in September 2007. Frogs were tracked using WTI-1000 VHF receivers and HHFA3 Yagi 3-element antennas (Wildlife Track, Caldwell, ID). After the first winter tracking session, it was determined that enough winter movement data was obtained such that it was no longer necessary to leave transmitters on the frogs throughout the winter, a time when the risk of transmitter batteries dying is greatly heightened. Therefore, all transmitters were removed in November 2006 for the winter.

With each frog relocation, data were collected which included whether the frog was visually located, time of relocation, and information on the frog's location (see Appendix A for details of data form). The geographic position of the frog was recorded with a Trimble GEO XT with TSCe 128 mb Windows datalogger or a Trimble GeoExplorer II (Trimble Navigation, Sunnyvale, CA). Recorded positions were post-processed using base stations in either Quincy or Susanville with GPS Pathfinder Office version 2.90 (Trimble Navigation Limited, Sunnyvale, CA) with a range of accuracy (68% probability) of 0.5m to 8.6m, but the majority (>95%) being less than 1.0m accuracy. At the end of each tracking session, frogs were recaptured, assessed for injuries caused by the radio transmitter attachment, and if

a)

b)

Figure 2. Mountain yellow-legged frogs (*Rana muscosa*) with attached radio transmitters for telemetry and movement study, Bean Creek, Plumas National Forest, a) July – October 2005 and b) October 2005 – September 2007.

healthy, were affixed with new transmitters, or in the case of the final tracking period, transmitters were removed and not replaced.

Water temperatures at the bottom, mid-point and top of the study reach were recorded with HOBO® H8 RH/Temp/Light Intensity/External channel data loggers w/ water-tight cases and HOBO® Pendant Temp/ Light waterproof data loggers (Onset Computer Corporation, Bourne, MA). Water temperature (°C) was recorded every 30 minutes throughout the study period.

In a previous study conducted on the same population by K. Matthews of Pacific Southwest Research Station (PSW), preliminary genetics testing was done on this population to determine the possibility that any individuals were possibly *Rana boylii* or hybrids. These analyses were conducted by Amy Lind of PSW and again by Jennifer Dever of University of San Francisco.

Data Analysis. All frog capture locations and relocation positions throughout the summer tracking session were exported to ArcView 3.3 (ESRI, Redlands, CA) as a shapefile for spatial analysis. Home ranges for each frog were calculated using the Animal Movement Extension version 2.0 (Hooge and Eichenlaub 2000) through the fixed kernel method. Both 50% and 95% utilization distribution probabilities were returned using a least cross squares validation as a smoothing parameter.

Frog movements between successive relocations were also analyzed using the Animal Movement extension for ArcView 3.3. The following parameters were calculated for each frog: cumulative and mean distance moved during the summer tracking session (m), total distance along stream-length from upstream-most point to downstream-most point (m), and largest single

movement (m). All statistical analyses were conducted using NCSS® (Number Cruncher Statistical Software, Kaysville, UT).

RESULTS

Frog Capture and Movements. The study reach for all seasons from July 2005 through September 2007 in which frogs were captured and tracked was approximately 3.5km (Figure 3). Sixty-two adult or subadult mountain yellow-legged frogs were captured between July 23, 2005 and September 17, 2007, but only fifty frogs (47 females, 3 males) were chosen for radio transmitter attachment. Radio-tagged frogs ranged from 57.5mm to 72.5mm in snout-vent length at capture. Weights of radio-tagged frogs at capture ranged from 24.0g to 57.5g at capture (see Appendix B for all morphometric data). All swabs analyzed for chytridiomycosis were negative.

Frogs were tracked between July 23, 2005 and August 5, 2007. All summarized movement data are shown in Table 1. The largest upstream to downstream distance along the creek by any frog over the survey period was 3300m.

Table 1. Summary of movement data for radio-tagged mountain yellow-legged frogs at Bean and Spanish Creeks, Plumas National Forest, 2005 – 2007.

	Maximum Single Movement (m)	Total Distance Moved (m)	Fixed Kernal Home-range 95% probability (m^2)	Fixed Kernal Home-range 50% probability (m^2)
Minimum	2.9	4.2	27	6
Maximum	2282.0	11,134.0	1,456,450	370,023
Mean	485.3	1733.3	167,032	38,030
Standard Error	83.9	361.2	49,033	12,404

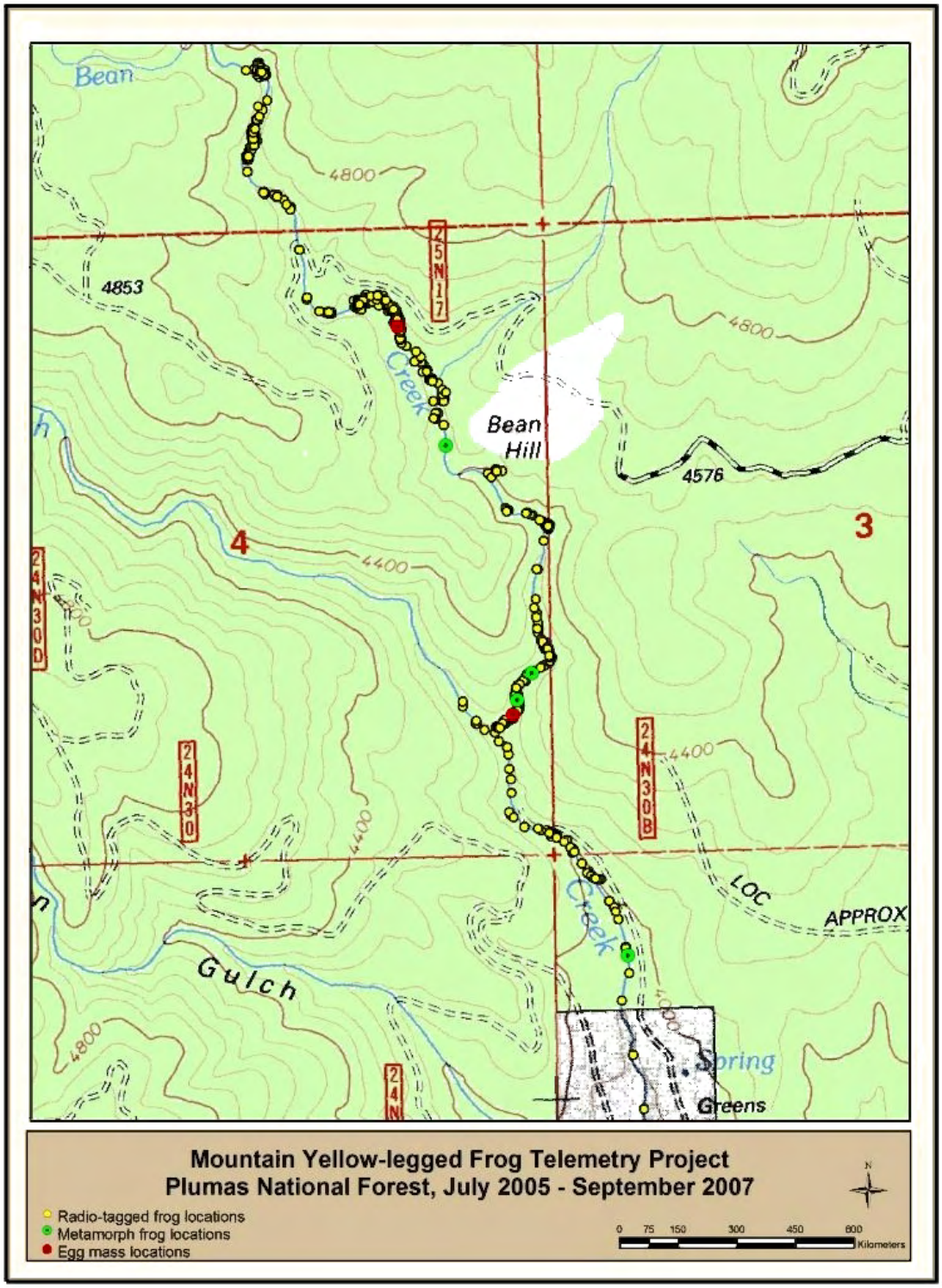

Figure 3. Study reach and all locations of frogs and egg masses throughout the study period July 2005 – September 2007 for the mountain yellow-legged frog telemetry project on Bean and Spanish Creeks, Plumas National Forest.

Frog Locations and Habitat. Habitat at frog locations and whether a frog was located in the stream or away varied over the tracking session. Of the 747 frog relocations in which frog location could be determined well enough to characterize habitat, frogs were visually located 643 times. Frogs were occasionally not visible to the observer due to them being obscured under rocks or under the stream bank. Often when frogs were relocated away from the stream, they were difficult to visually find due to dense brush or leaf litter.

Frogs were located above water in the stream 409 times (54.8%), underwater 165 times (22.0%), at the stream edge 20 times (2.7%), away from the stream 138 times (18.5%), and 15 times where location could not be accurately determined (2.0%). However, frogs were only observed beyond 0.20m from the stream in 105 relocations (14%). When frogs were away from the stream, distance from the stream edge ranged from 0.05m to 22.0m. Frogs were associated with different microhabitats as well. Of 733 relocations where microhabitat association was reported, frogs were associated with rocks 565 times (73.7%). Other habitat types that frogs were associated with included reeds, wood, bedrock, brush , cobble, bedrock, mud banks, a combination of two or more of these habitat types, or were found floating in the water (Figure 4).

Canopy cover was variable throughout the study reach and ranged from 0% to approximately 50% at some of the less anthropogenically-disturbed areas. Vegetation along the stream banks included annual sedges, various types of brush, willows (*Salix* spp.), with some areas of the reach having no vegetation. In the 728 frog relocations where sun or shade was reported, frogs were located in the shade in 563 relocations (77.3%), although this tendency was affected by whether respective sections of the creek where frogs were located happened to be exposed to sunlight. Frogs were located in the sun in 148 times (20.3%) and in mixed shade/ sun

in 17 relocations (2.3%). Although no systematic data were collected on frog locations in relation to stream habitat type, it was noted that frogs were often located after the ends of riffles in pools.

Stream temperature fluctuated throughout the tracking session. Because the study reach changed between years and over the seasons, dataloggers were placed in different areas of Bean and Spanish Creeks. In general, water temperatures remained relatively stable, though with daily fluctuations, over the summer. There was a clear, but gradual, drop in temperature through the fall until dataloggers were removed from the creeks in November. For an overview of water temperatures over the survey period, see Appendix C.

Other data collected. Throughout the >2 year tracking period, only three egg masses were observed. Two occurred in Bean Creek about 100m above the confluence of Bean and Spanish Creeks, and one occurred in the upper part of Bean Creek about 0.3mi below the culvert. California newts (*Taricha torosa*) were observed feeding on larval frogs several times near the egg masses in lower Bean Creek.

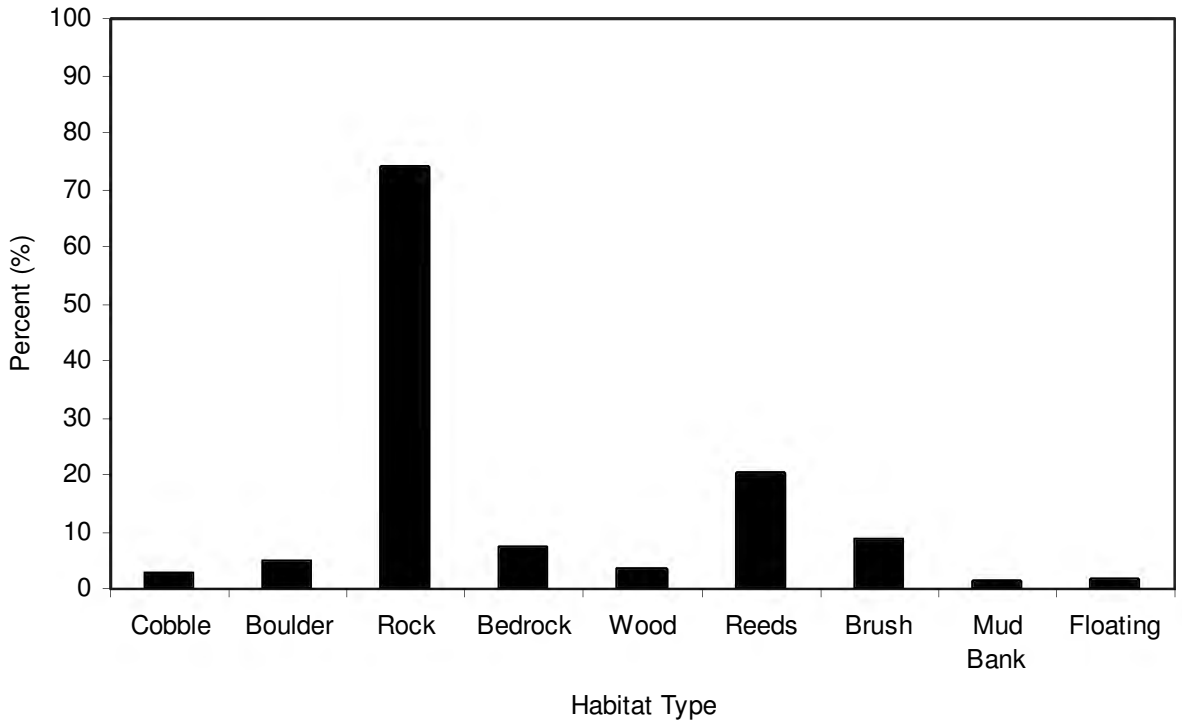

Figure 4. Habitat types that mountain yellow-legged frogs were associated with when located through radio-tracking at Bean and Spanish Creeks, Plumas National Forest. The percentages of 733 frog relocations are indicated for each habitat type. Percentages sum to over 100% because frogs were often associated with more than one habitat type at a single relocation.

Frog metamorphs were also observed within both Bean and Spanish Creeks. In all instances, these frogs were less than 1.0g in weight and were likely newly metamorphosed. No metamorphs were observed in upper Bean Creek, though several were encountered in lower Bean Creek near the confluence with Spanish Creek, and close to where the egg masses were found (see Figure 3 for metamorph locations). A group of three metamorphs was found mid-reach in Bean Creek below the mine tailings at Bean Hill. One metamorph was found in Spanish Creek (see Appendix D for photos of an egg mass and metamorph). All metamorphs were found during the breeding season, between May and June of each year.

Most frogs captured were swabbed and assessed for chytridiomycosis, and results have been obtained for the first eighteen. These frogs tested negative for the pathogen.

Genetic analyses on this population were contradictory. The first analyses suggested that these frogs were *Rana boylii*. However, further testing through the use of Random Amplified Polymorphic DNA methods indicated that these frogs were more likely *Rana muscosa*. Due to conflicting results from the first set of analyses, more thorough genetic testing should be completed.

QUALITY CONTROL ACTIVITIES

Quality control was conducted through multiple means. As per the survey plan, surveyor positions along the creek were assessed through the recorded positions generated by the Trimble GPS unit. It was guaranteed that the surveyor was actually at the point recorded since reliable positions were recorded through the Trimble GPS unit. Additionally, surveyors were asked to flag each frog location as they were encountered. This accomplished two tasks. First, it could be verified that the surveyor was actually at that point. Additionally, the flags allowed a way to

ensure that frog positions were identified in the event that the Trimble files were lost or corrupt. These flags were removed the following week after they were cross-referenced with the GPS files generated the previous week. Each surveyor also carried a recreational grade GPS unit. The surveyor recorded his/ her own movements via the "track log" feature. Surveyor track logs were inspected by the Project Manager to verify that the surveyor traveled the full study reach of the creek.

QUALITY CONTROL ASSESSMENT

Through the aforementioned methods, it was determined that the requirements and tasks described in the contract were met with a high level of quality and compliance. Trimble GPS generated files indicated that surveyors recorded positions along the study reach of Bean Creek, missing only a few throughout the study period. These few instances that no GPS files were generated were occasions when the frog was not relocated, and this was indicated in the data form as such.

DISCUSSION

In this project, we were able to summarize many aspects of frog movements and ecology in a lower elevation stream in northern Sierra Nevada. Total home range, total movement, microhabitat use and some other features of frog ecology were highlighted through this study. One aspect of frog ecology that this study was unable to summarize is the difference in the parameters addressed between female and male frogs. In all years of this study, only three male frogs were captured and tracked. Though occasionally, untagged male frogs were encountered throughout the survey period, they were relatively rare. Throughout the entire study period, only

six adult male frogs were observed in Bean Creek and none were observed in Spanish Creek. It is unknown whether this is due to a highly skewed sex ratio or a spatial separation of male and female frogs across the watershed. However, it should be noted that the locations where egg masses were found were within close proximity to the radio-tagged males, and in the case of the downstream egg masses, was within the same pool as the male.

A general movement pattern was noted throughout all years of this study that was based on seasonal changes in weather. From early summer into late fall (late June to October), frogs remained roughly in the same vicinity (within about 50m). In both years, shortly after the first major precipitation event, frogs were observed to move downstream, sometimes great distances (up to 2km). Most frogs remained in these downstream wintering areas until early to late May. Wintering sites usually consisted of a rock crevice, an undercut bank, or a seep within a mud hole. Then, presumably in response to breeding season initiation, most frogs again moved downstream, usually to the confluence with Spanish Creek, or in some cases, into Spanish Creek. For this reason, it is thought that most of the breeding occurs at or below the confluence with Spanish Creek. Possibly the more open and larger pools and more permanent water in the lower reach of Bean Creek and within Spanish Creek provide better and more reliable breeding opportunities for frogs in these areas.

Interestingly, it was only in the second year of the study that several frogs moved into Spanish Creek during the breeding season. Although in 2007, frogs were not radio-tagged until well into the breeding season, it was noted that as the breeding season closed, all frogs then moved upstream, back into Bean Creek. Spanish Creek is characterized by many deep pools (up to 2m) and long, shallow runs, which may provide suitable sites for egg mass attachment. However, no egg masses were found in this creek. The question remains whether breeding is

occurring only at the confluence where most egg masses were found, or elsewhere in the watershed that has not been identified yet.

The variation in home ranges found in this study may be misleading for two reasons. First, individual frogs were tracked through different periods throughout the session, and may or may not represent the wintering and breeding movements. The greater home ranges were of those frogs whose movements were tracked during both the downstream migration with the precipitation and the breeding movements, and occasionally, the subsequent move back upstream after breeding. Second, the Fixed Kernal method is not calibrated for estimating home ranges along linear areas, and likely overestimates the home ranges of stream-dwelling species. In actuality, frog movements were restricted to the creek with occasional small movements out of the stream; however, the calculated home ranges and depictions suggest great movement out of the stream. It should be noted that this method of home range calculation has an inherent bias toward species with more regular home range shapes. Further analysis of these data should incorporate a method more applicable to species with linear home ranges.

Results of this study indicated that frogs infrequently move far from the main channel of the creek. In the few instances that frogs were found away from the creek more than 1m and up to 22m, they were located in small side pools in mostly dry channels, among tree roots, or up small tributaries, almost always associated with water. These off-creek movements were also more frequent during the winter when there were likely more off-creek refugia for frogs. This off-creek habitat may be especially important to consider in the wetter months, as more habitat is created and available to frogs away from the creek. Much of the habitat along the study reach on Bean and Spanish Creeks is characterized by sparse canopy cover, dry, rocky substrate, and steep slopes, which is typical of only some of the riparian habitat types throughout Plumas National

Forest. However, off-creek movements by mountain yellow-legged frogs at high elevation lakes in the southern Sierra Nevada occurred over dry, rocky substrate with few trees for refugia (Pope and Matthews 2001), so the off-creek habitat at Bean and Spanish Creeks is likely more similar to typical areas inhabited by this species than the densely vegetated, wetter riparian habitats represented throughout Plumas National Forest.

This research does indicate that frogs are capable of using off-creek habitats within the forest, provided there are wet refugia. As these larger (22m) off-creek movements occurred only in the winter, special consideration should be made at this site, and other sites like this, for any projects that occur near creeks. Especially in watersheds where stream-dwelling frog species have been documented, wet seeps and seasonal tributaries should be considered suitable habitat for these species, especially in the winter.

Initially, there was concern that this population of frogs was either foothill yellow-legged frog (*Rana boylii*) or a hybrid-cross between mountain yellow-legged frog and foothill yellow-legged frog. This idea was supported by the possession by these frogs of characteristics of both mountain yellow-legged frogs (dark toe tips, larger size, occasional garlic odor) and foothill yellow-legged frog (rough skin, most frogs with lack of odor, National Audubon Society 1979). However, preliminary genetic results from 2003 indicated that they were likely *R. boylii*. Then, in 2005, re-analysis of the same genetic samples suggested that they were genetically dissimilar to verified *R. boylii* samples, and were more likely *R. muscosa*. These results, however, did not preclude the possibility of this population being a hybrid between the two species. Additionally, an isolated population of *R. muscosa* with characteristics much closer in appearance to typical *R. muscosa* was discovered several kilometers upstream from the studied population (K. Matthews, USFS, 2005, pers. comm.), indicating a possible genetic dissimilarity between the two

populations. Further genetic analysis could determine whether in fact this population represents a hybrid population of Ranid species.

Recent research into the feasibility of using frog chin spot patterns to identify individuals (J. Bettaso, 2005, EartHerp, Manila, CA, pers. comm.) prompted us to photograph each frog's unique chin spots at capture. This allowed us to verify the identity of many unmarked frogs when they were opportunistically captured. Furthermore, this presents a new, less invasive way to track individual frogs over time.

In summary, this three-year project and partnership between MGW Biological and biologists from Plumas National Forest has been successful in further defining the ecology of *R. muscosa* in lower elevation streams of Plumas National Forest. Movements throughout the Bean/ Spanish Creek watershed have been described along with habitat use and breeding areas. A description of off-creek movements has been generated through this project and should help to provide stream-dwelling frog conservation considerations for Plumas National Forest's management activities.

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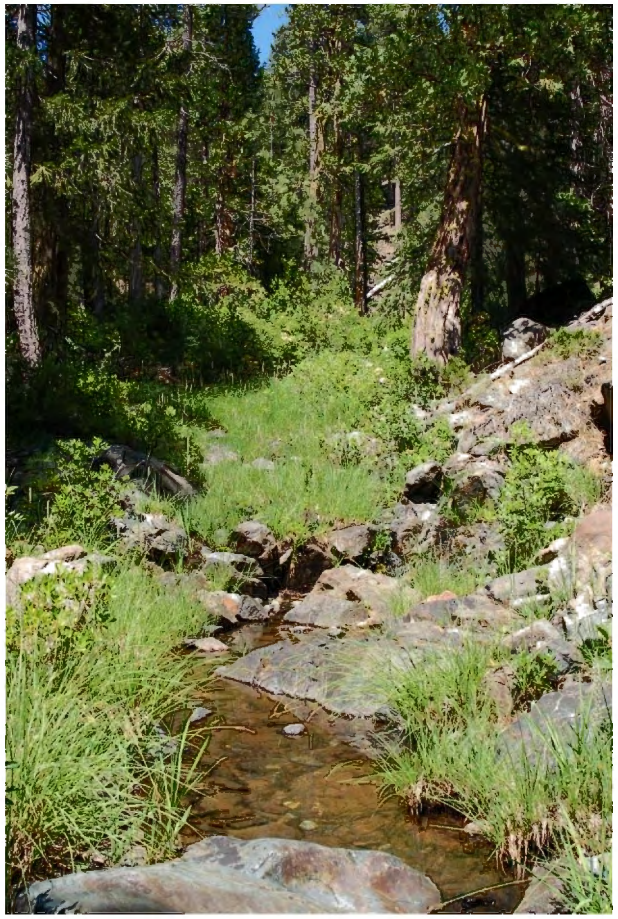
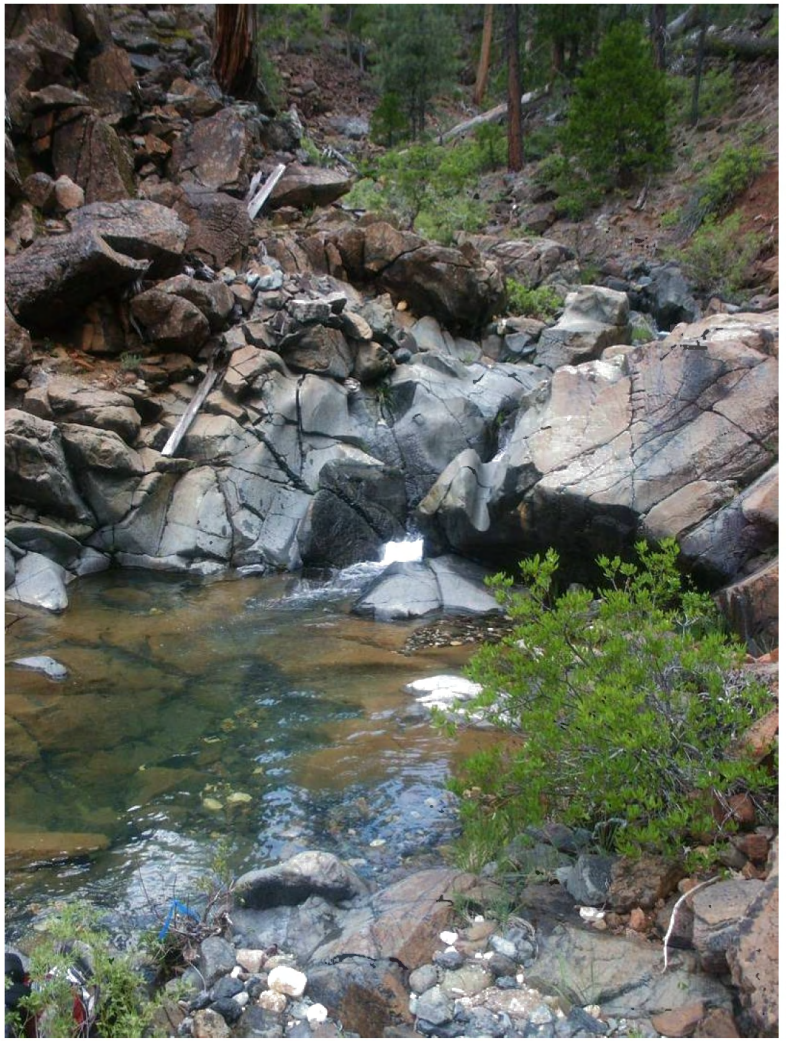
Appendix A. Photos of typical habitat types along Bean and Spanish Creeks, Plumas National Forest.



Upper Bean Creek

Upper-mid Bean Creek

Lower-mid Bean Creek



Lower Bean Creek

Lower Bean Creek

Upper Spanish Creek

Appendix B. All frog morphometric data throughout the mountain yellow-legged frog telemetry study period, July 2005 through September 2007 on the Plumas National Forest.

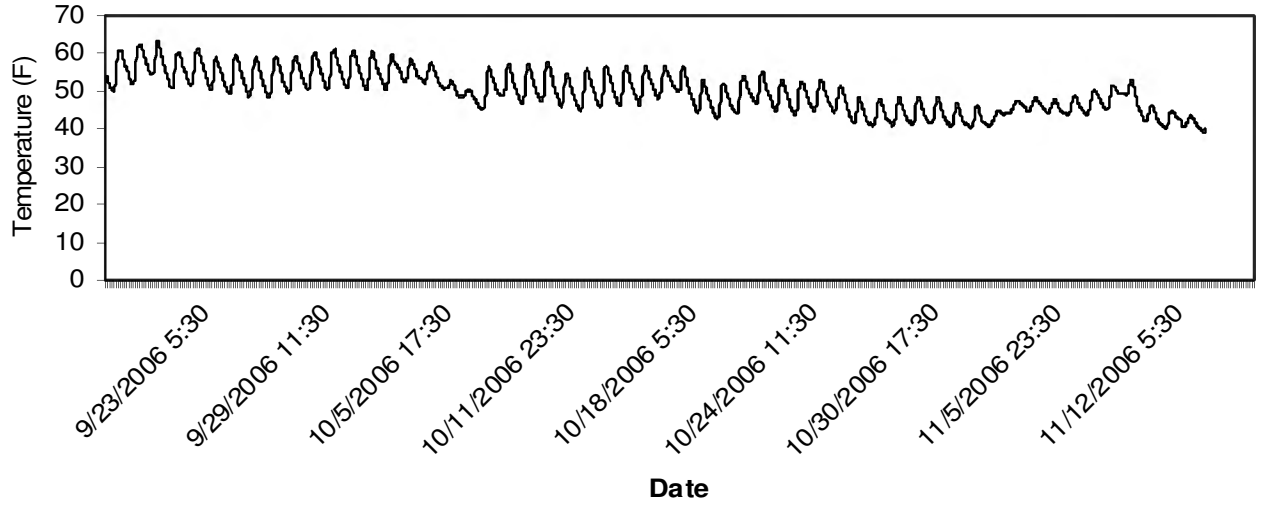
	7/05/2005		10/07/2005		11/16/2005		11/16/2005		5/08/2006		6/2/2006		6/6/2006		7/2/2006		8/1/2006		10/1/2006		11/13/2006		4/1/2007		6/1/2007		6/1/2007		7/1/2007		8/1/2007	
Frog ID	Snout-vent length (mm)	Weight (g)	Snout-vent length (mm)	Weight (g)	Snout-vent length (mm)	Weight (g)	Snout-vent length (mm)	Weight (g)	Snout-vent length (mm)	Weight (g)	Snout-vent length (mm)	Weight (g)	Snout-vent length (mm)	Weight (g)	Snout-vent length (mm)	Weight (g)	Snout-vent length (mm)	Weight (g)	Snout-vent length (mm)	Weight (g)	Snout-vent length (mm)	Weight (g)	Snout-vent length	Weight (g)	Snout-vent length	Weight (g)	Snout-vent length	Weight (g)	Snout-vent length	Weight (g)	Snout-vent length	Weight (g)
F01	61.0	27.5	61.2	35.5				31.0																								
F02	62.8	33.0	62.6	46.0				?	63.5	35.0			ns	ns																		
F03	63.6	30.5	64.4	39.0				37.0																								
F04	65.6	41.0	64.1	38.0										26.0		25.5																
F05	66.3	42.0	67.4	49.0																												
F06	66.4	39.0	67.6	54.0							66.6	42.5																				
F07	66.7	38.5	66.1	48.0				40.0			61.4	43.0						50.0			71.0											
F08	68.1	47.5	70.5	57.0				52.0			66.6	45.5																				
F09	70.2	45.0	70.9	50.5																												
F10	63.6	31.5	68.3	40.0				41.0			65.5	35.5				28.0	31.0															
F11	65.3	35.5	67.3	44.0			64.2	40.0																			67.0	45.0				
F12	63.7	35.0						41.0			61.4	37.0																				
F13	72.4	48.0																														
F14	72.5	41.5	72.3	48.0																												
F15	69.6	40.0																														
F16	58.2	31.5	61.7	32.0				30.0		29.0																						
F17	66.8	38.0													64.0	35.0																
F18	64.2	31.5			63.4	35.0		34.0																								
F19			70.7	57.5																												
F20			60.9	26.0																												
F21			66.8	43.0											63.2	29.5																
F22			66.6	57.0				52.0							71.0	36.0																
F23			61.9	31.0				32.0		31.0							32.0		48.0													
F24					68.3	47.0		43.0					66.0	42.0			24.0	67.5	39.5		69.0			69.0	35.0			71.0	37.0			
F25					69.3	43.0		44.0			ns	36.9				32.0																
F26					70.3	46.0													45.0		67.0											
F27							63.0	38.0																								
F28									68.0	52.0																						
F29									67.0	52.0																						
F30															61.0	33.0	27.0	57.5	27.0		60.0	62.0	27.0									
F31															70.0	58.0																
F32															61.0	30.0	31.0				65.0	70.0	45.0									
F33															61.0	26.0	25.0															
F34															61.0	29.0				35.0	66.0			64.0	29.0							

Appendix B. continued

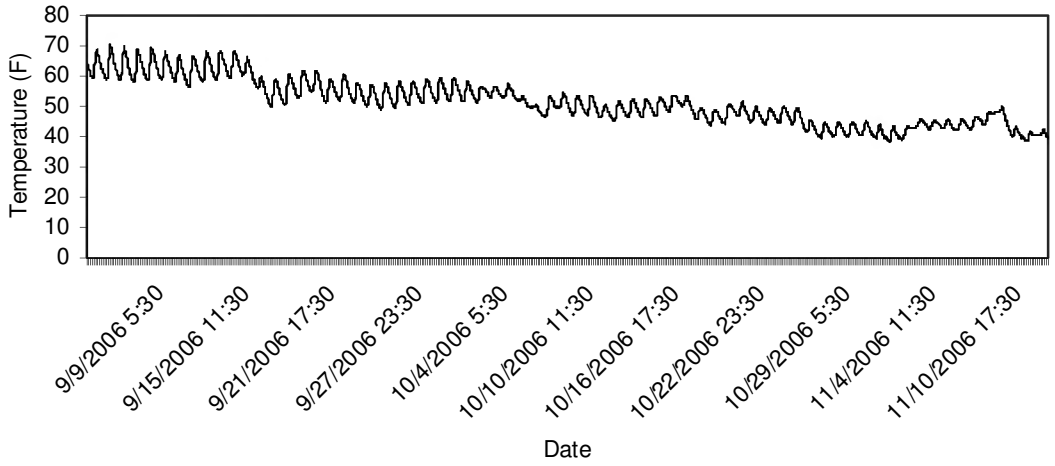
| | | |

Appendix C. Summary of water temperature data from several points throughout the study reach and survey period at Bean and Spanish Creek for the mountain yellow-legged frog telemetry project, July 2005 – September 2007.

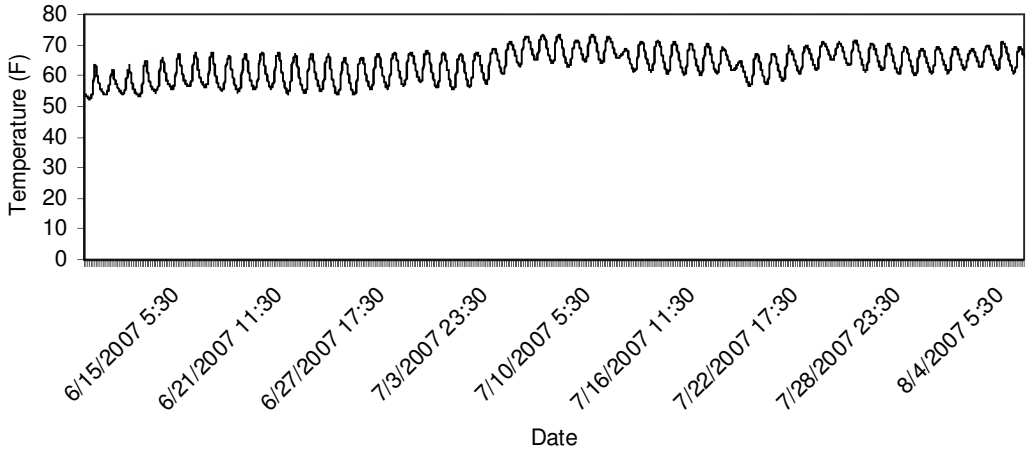
Upper Bean Creek: September 17 – November 12, 2006



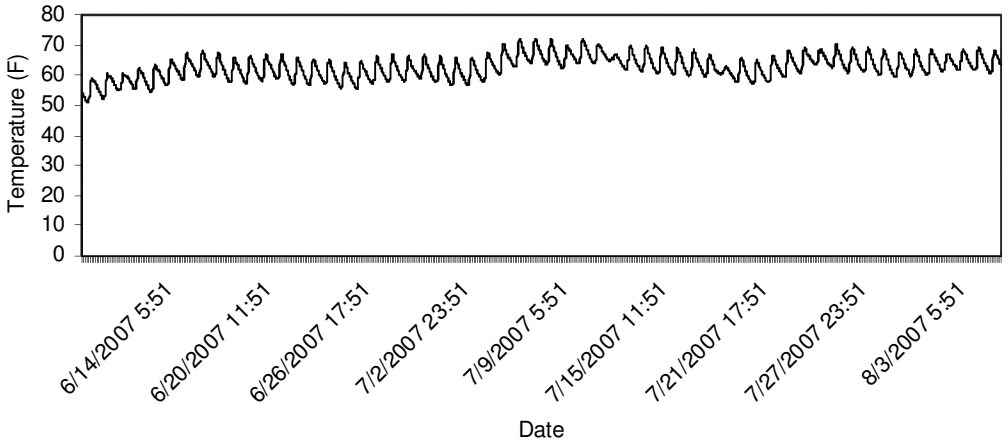
Lower Bean Creek: September 9 – November 12, 2006



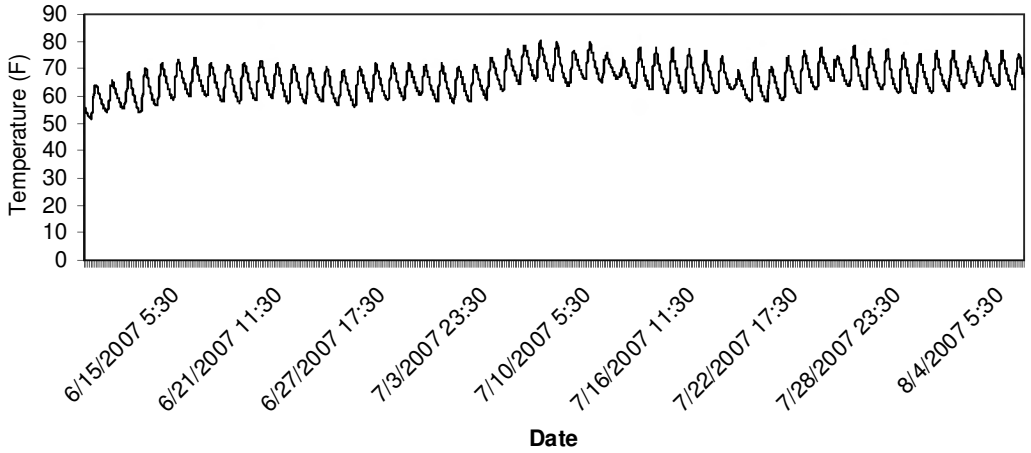
Upper Bean Creek: June 8 – August 5, 2007



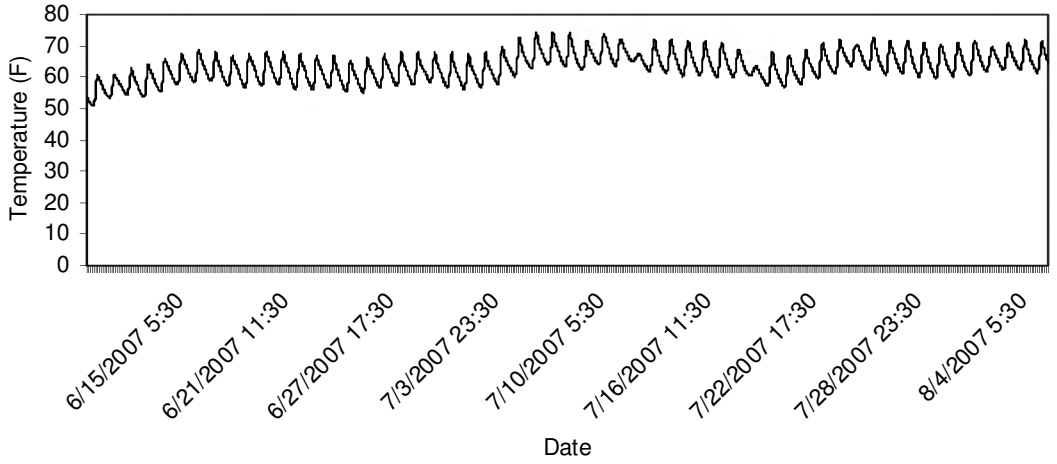
Mid Bean Creek: June 8 – August 5, 2007



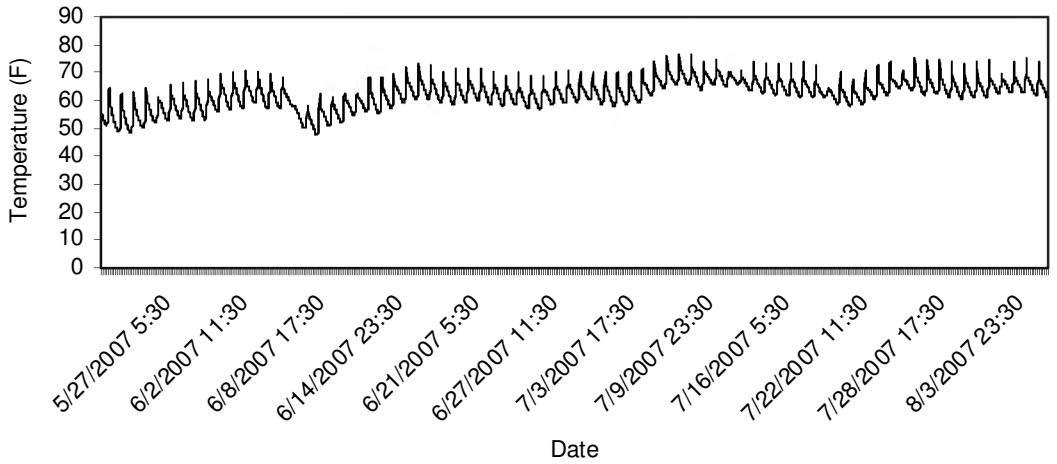
Lower Bean Creek: June 8 – August 5, 2007


90
80
70
60
50
40
30
20
10
0
Temperature (F)
6/15/2007 5:30
6/21/2007 11:30
6/27/2007 17:30
7/3/2007 23:30
7/10/2007 5:30
7/16/2007 11:30
7/22/2007 17:30
7/28/2007 23:30
8/4/2007 5:30
Date

Upper Spanish Creek: June 8 – August 5, 2007



Lower Spanish Creek: June 8 – August 5, 2007



Appendix D. Photo of mountain yellow-legged frog metamorph and egg mass found June 2006 at lower end of Bean Creek about 100m above the confluence with Spanish Creek, Plumas National Forest.